Hughes HeloSat™

Not Getting the Full Picture?

Beyond Line of Sight SATCOM For Rotary Wing Aircraft

HUGHES®
An EchoStar Company

@hughesconnects
hughes.com/helosat

11717 Exploration Lane Germantown, MD 20876 USA

Executive Summary

Due to their size and maneuverability, helicopters and other rotary wing aircraft are ideal for Intelligence, Surveillance, and Reconnaissance (ISR). Yet their fast-moving rotor blades – the very feature that makes them so nimble – makes satellite communications (SATCOM) difficult, thereby limiting their use for long distance ISR missions.

Until now, rotary wing aircraft could only provide live video and data by way of Line of Sight (LoS) microwave technologies where the aircraft would link to a receiver mounted on a tower. For rotary aircraft to gather HD video intelligence Beyond Line of Sight (BLoS), or operate in environments that don't have the necessary infrastructure, would entail flying to the destination, collecting the data and then returning for analysis. As a result, helicopters have remained largely underutilized for long distance ISR missions that require bandwidth intensive real-time video and data.

This paper describes a BLoS Wideband (WB) satellite communications system from Hughes which eliminates this obstacle by enabling communications signals to pass reliably through rotor blades. Hughes system engineering experts developed patented waveform enhancements using specialized algorithms embedded within software definable modem technology to create the Hughes HeloSat™ System. Designed as an open architecture solution for BLoS SATCOM in which the technical capabilities are independent of helicopter type, HeloSat operates in the X-, Ku-, and Ka-bands, employing resilient waveform technology optimized for rotary platforms and based on commercially proven systems. With this integrated BLoS connectivity, rotary aircraft can now be deployed to perform long-distance ISR missions delivering real-time video and data for analysis.

With deep commercial aeronautical satellite communications expertise, Hughes has the experience as a SATCOM systems integrator and a long-standing legacy with the United States Department of Defense (DoD) in the development of advanced technology solutions such as the HeloSat system.

The Challenges

The Blades

For mission-reliable connectivity, SATCOM transmissions must be able to operate regardless of design properties and variations.

Central to the challenge of reliable communications on rotary wing platforms is overcoming the signal loss caused by rotating blades. Regardless of where the terminal is mounted on a helicopter, the blades rotating between the aircraft and the satellite will inevitably disrupt the signal, prompting a pattern of signal acquisition, loss, and reacquisition.

Adding to the complexity of the challenge, different rotary aircraft platforms employ different kinds of blades. Helicopter and other rotary wing aircraft blades vary by size, materials, and shapes, each with unique properties, such as counter rotating blades or rotations per minute (RPM). A solution for one type of aircraft may not work for others due to these configurable nuances.

Going the Distance

For reliable, wideband SATCOM connectivity on helicopters, the solution must function Beyond-Line of Sight (BLoS).

Helicopters and other rotary wing aircraft have access to ample bandwidth when using LoS microwave communications to local towers. However, the average LoS limit for rotary wing aircraft is 60 miles (depending on flight altitude and tower height) before the signal is lost due to the earth's curvature. When these aircraft operate over long distances or through mountainous terrain, they cannot send and receive data more complex than voice or text due to the limited bandwidth of other RF or narrowband SATCOM services. This gap in capabilities has disqualified rotary wing aircraft for long distance ISR missions.

Size, Weight, and Power Constraints

SATCOM system components for rotary wing aircraft must meet critical SWaP thresholds.

On small aircraft designed to be nimble and fast, limits in Size, Weight and Power (SWaP) properties must be considered along with the advantages gained from any new technology. For example, using a power amplifier on a SATCOM system might boost the signal 6–10 dB to transmit through the blades; however, it would also dramatically increase the cost and SWaP properties to the point of impracticality.

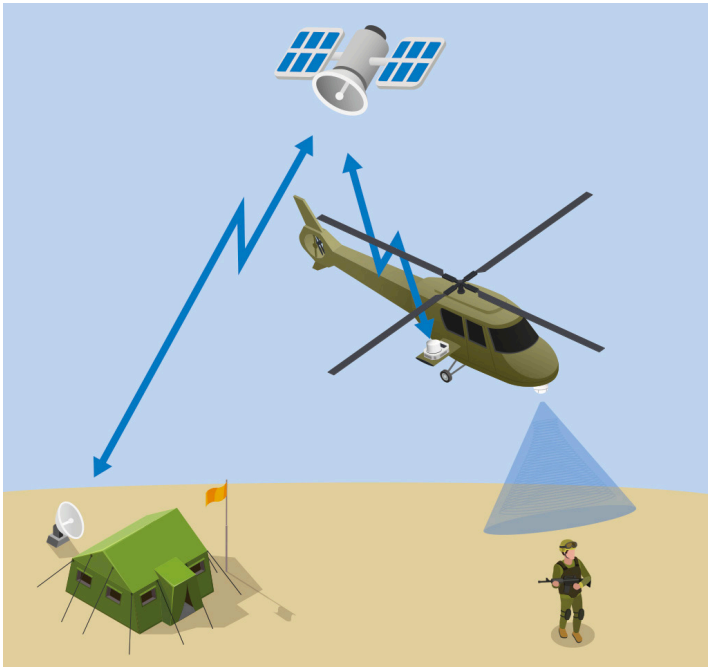
Real-time Situational Awareness

To be useful for ISR, SATCOM solutions for rotary wing aircraft must be capable of delivering the necessary bandwidth to transmit HD video at a cost that is practical.

Today's airborne ISR missions depend more than ever on reliable transmission of high definition video and data, especially for sensitive situational awareness information to reach decision makers on the ground. While narrowband SATCOM solutions for rotary aircraft have a natural waveform that allows for transmission through blades with minimal modification, they can only reliably transmit low data rates (typically up to 1 Mbps), which is inadequate for bandwidth-hungry applications such as HD video. Furthermore, service rates for these systems are quite expensive and typically billed by the minute, adding another layer of operational constraint to the mission.

The Solution: Hughes HeloSat

The Hughes HeloSat System capitalizes on proven commercial technologies to provide two-way BLoS SATCOM for rotary wing



Hughes HeloSat provides connectivity between the blades, enabling line-of-sight and beyond-line-of-sight communications.

aircraft. HeloSat features an optimized modem and antenna form factor with reduced SWaP properties to accommodate payload limitations. This technology, in conjunction with a variety of small, lightweight antenna options, provides powerful connectivity to support real-time situational awareness on different rotary wing platforms operating where LoS communications are unavailable. Designed with an open standards architecture, this innovative solution enables a customizable system for sharing of real-time situational awareness from the sky to decision-makers on the ground.

Hughes HeloSat System technology operates over key operational frequency bands (Ku, Ka, and X), to meet the needs of modern military applications. With this flexibility, commands can achieve up to 10 Mbps off the aircraft over commercial high-throughput satellites and benefit from low data transmission costs.

BLoS Without Blind Spots: HeloSat 360

The Hughes HeloSat System can be configured to match mission and aircraft requirements. With two modems connected to two antennas mounted on the sides of an aircraft, it provides complete 360° of in-flight connectivity, so pilots can operate their aircraft without concern of ever losing the signal. An optional single terminal HeloSat solution offers an estimated 270° of in-flight connectivity, limited by blockage from the rotor base or fuselage, but with rapid reacquisition.

In the two terminal configuration, each automatically hands the signal back to the other depending upon which has the strongest signal. Mounted on top of the armament subsystem platform with one terminal on each side of the helicopter, the easy roll-on/roll-off installation has two primary benefits. First, it allows for the full 360° of connectivity eliminating signal blockage; and secondly, it makes for an agile and cost-effective solution by eliminating expensive structural changes to the aircraft and associated costs for re-certification of flight-worthiness.

Powered by The Hughes HM System

The foundation of HeloSat is the Hughes HM System. Engineered based on software-definable modem (SDM) technology and the Hughes scrambled code multiple access (SCMA) waveform, the HM System brings cost-effective and commercial-off-the-shelf (COTS) communications products and solutions ideal for military applications. The HM System employs a commercially-based, open standards architecture and frequency band-agnostic platform that enables affordable, resilient solutions to meet a wide variety of mobility and portability requirements for government users.

Waveform Enhancements

Continuing the Hughes legacy of innovative satellite solutions, the patented waveform utilizes the latest software-definable SCMA technology enabling high-data throughput, and secure and efficient sharing of bandwidth. Hughes SCMA waveform technology is especially well-suited for employing extremely small antennas (micro-terminals), which also allows for rapid signal acquisition and recovery. The waveform includes Upper-Layer Protocol Enhancements (ULPEs) for high-speed transmission with zero packet loss through the rotating blades of a helicopter.

The advanced waveform implementation for rotary wing aircraft also has a Single Channel per Carrier (SCPC), which utilizes a similar algorithm for both forward and return transmission. Since overcoming rotary blade blockage is an issue in both directions, the hardware platform is the same for the two links. Whether it be video, data or voice traffic encapsulated in an IP packet, communications between the hub and the aircraft become independent connections with continuous transmissions up and down, even when no active messaging is helping to frame synchronization and reacquisition.

HM400 Modem

Building on the success of the award-winning HM200, the HM400 COTM modem (See Appendix B) utilizes the innovative Hughes SCMA waveform technology that enables efficient bandwidth usage with smaller antennas. The HM400 was also designed with flexibility in mind; its open architecture can be used with a range of qualified system components suited for meeting mission-specific requirements. One critical enhancement in the HM400 is increased resiliency, which enables reliable BLoS communications even in harsh or contested environmental conditions, such as ultra-high-altitude flight, lightning strikes, and Electromagnetic Interference (EMI). This makes the unit ideal for disaster response, storm tracking, military operations, agriculture and geological surveys, and other applications.

Tested. Proven. Ready.

Hughes HeloSat enables rotary wing aircraft to stay connected and communicate from farther distances than ever before. With easy roll-on/roll-off or permanent installation, Hughes HeloSat adapts easily for any rotary wing platform, regardless of the number of blades or where the antenna is installed. The patented technology has been tested and proven on 9 different rotary platforms to date showcasing its ability to overcome rotary blade interference to deliver high-throughput speeds for high-definition video, SIGINT sensor data, voice over IP and other critical data transmission needs with zero packet loss.

With its open architecture, Hughes HeloSat can support multiple mission sets, including ISR, border security, law enforcement, and disaster response. Helicopters and rotary wing aircraft can finally go the distance for the critical ISR missions for which they are so well suited.

HUGHES
An EchoStar Company

11717 Exploration Lane
Germantown, MD 20876 USA